INCORPORATION OF SUSPENSION ELEMENTS IN VEHICLE FRAME COMPONENTS

BACKGROUND OF THE INVENTION

[1] This invention relates to the incorporation of suspension components in a vehicle frame element to reduce required space for the suspension components.

[2] Vehicles are typically provided with suspensions including springs, both mechanical and fluid. The springs provide a bias support allowing movement of the vehicle wheels relative to the frame, with resistance to dampen any shock due to a road bump, etc. Typically, a number of arms connect the vehicle wheels to frame elements, with springs positioned between the arms and the frames.

[3] Vehicles are being provided with more modular type frames. As an example, the engine is often mounted in an engine cradle module consisting of a plurality of generally tubular frame elements. Similarly, a rear frame module typically extends between the sides of the vehicle frame, and provides a mount location for the wheels. Again, this frame element includes generally tubular shaped structures. Various other types of modular supports, including corner sections, are known and utilized in modern vehicles.

[4] In modern vehicle designs it would be desirable to reduce the number of separate components, and further to reduce the amount of required space. However, to date, the frame elements and the suspension components have been separate and have each required their own space.

SUMMARY OF THE INVENTION

[5] In a disclosed embodiment of this invention, a vehicle frame member preferably houses suspension components. The suspension components could be mechanical springs, fluid spring elements, air reservoirs, or other suspension components. The frame member could be any of a number of generally tubular structures. Tubular should not be interpreted as round for purposes of this application. The tubular structures could be rectangular. Most preferably, the frame member which houses the suspension members extends between the two lateral

sides of the vehicle. Thus, a single frame member houses suspension components for each of the opposed vehicle wheels.

[6] In a disclosed embodiment of this invention, the frame member could be a portion of the engine cradle. In another disclosed embodiment the frame member could be part of a rear modular frame. Further, in yet another embodiment the component is a corner module. The corner module would not have the feature wherein the frame member extends between the lateral sides of the vehicle.

[7] In one further embodiment an entire front vehicle modular could be provided which includes both the engine cradle, the vehicle fire wall, and the suspensions for both of the forward wheels. This embodiment would allow the provision of a good deal of the vehicle as a singular modular unit.

[8] In some embodiments, the suspension elements housed in the tube are coil springs. In this embodiment, the shape of the frame member may preferably be of any known shape, and can be dictated more by the necessary function of the frame member. In other embodiments wherein fluid springs are housed within the frame element, it would be more desirable to have the frame element be circular. With this embodiment, it is preferable the bore in the frame element be circular as to facilitate the movement of the fluid piston.

[9] These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

BRIEF DESCRIPTION OF THE DRAWINGS

[10] Figure 1 is a schematic view of a first embodiment.

[11] Figure 2A is a side view of a second embodiment.

[12] Figure 2B shows a top view of the Figure 2A embodiment.

[13] Figure 3 shows yet another embodiment.

[14] Figure 4 shows yet another embodiment.

[15] Figure 5 shows mechanical features which can be incorporated into any of the Figures 1-4 embodiments.

[16] Figure 6 shows a fluid arrangement which can be incorporated into any of the Figure 1-4 embodiments.

[17] Figure 7 shows yet another fluid arrangement.

[18] Figure 8A shows yet another fluid arrangement.

[19] Figure 8B shows yet another fluid arrangement.

[20] Figure 9 shows yet another fluid arrangement.

[21] Figure 10 shows yet another fluid arrangement.

[22] Figure 11 shows yet another fluid arrangement.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[23] Figure 1 shows an embodiment 20 wherein an engine cradle 22 has a pair of longitudinally extending sides 24 and a laterally extending side 26. The laterally extending side 26 has an inner bore 27. That is, the side 26 is generally tubular and extends between the sides of the engine cradle 22. As shown schematically, an engine 28 is supported on the engine 22 cradle as known. In the prior art such engine cradles exist, and have sometimes received suspension components to mount a wheel 30. Further, the frame sides 26 have been generally elongate tubular components, but have never been utilized to house suspension components. Sides 26 are typically welded to sides 24.

[24] As shown schematically at 32, in the present invention suspension components are housed within the bore 27. The types of suspension components are shown extremely schematically in the figures 1-4, as the purpose of the first several figures are to show possible environmental locations for the frame members. Subsequent figures 5 and higher show examples of the types of suspension components which could be housed within the tubular frame members. Any of the first four figures could be the environment for the suspension components such as mounted with any of the suspension component embodiments illustrated in Figure 5 and higher.

[25] Figure 2A shows another embodiment 35 wherein lateral sides 36 of the vehicle are bolted to a crossing rear modular frame 38. Again, the modular frame 38 may have an internal bore 40.

[26] As shown in Figure 2B, the frame portion 38 extends between the wheels 30, and also between the two lateral sides 36 of the vehicle. Again, suspension elements 32 are mounted within bore 40.

[27] Figure 3 shows yet another embodiment 42 which may be a corner module, and wherein the crossing member 44 is fixed, such as by bolting to frame members 46. The frame member 44 provides structural support for the vehicle frame, and houses a suspension component 32. Notably, in this embodiment the tubular frame member 44 does not extend across the lateral sides of the vehicle.

[28] Figure 4 shows an embodiment 80 wherein side walls, known as the wheel house 82 of an engine mount including fire wall 83 and a radiator support 84 are all formed as a complete modular unit. Mounting arms 86 are mounted to the sides of the walls 82. A crossing frame component 87 crosses between the lateral sides of the system and has suspension components 32 mounted to the arms 86.

[29] The above modular units are shown schematically, and are all generally known. In each of the embodiments it is the inclusion of suspension components within a generally tubular frame body which is inventive. The frame members are preferably removably attached, such as by bolting to the vehicle frame. However, welding or other attachments may be used.

[30] As shown in Figure 5, coil over shock 72 are mounted within the bore 74 of frame 69, and connect into a member 75 to in turn connect through an arm 76, which is in turn connected to a knuckle 77, also connected to an upper arm 78. Again, all of this structure connects to a wheel 71. The inclusion of the coil over shock 72 into the frame 69 provides better space usage, and minimized the necessary space underneath the vehicle. A fixed frame 73 is welded into frame 69 as a base for the coil over shock. As is known, space under the vehicle is at a premium and the present invention thus provides very valuable benefits.

[31] Further as shown in Figure 5, the frame component 69 extends between the two lateral sides of the vehicle, although only one side is showing detail in this figure. Although it is preferred the frame member extend between the lateral sides, single side frames such as a corner module and as shown schematically in Figure 3

may also benefit from this embodiment, and each of the following embodiments with appropriate modification.

[32] Figure 6 shows one half of an embodiment 50 wherein the crossing frame member 52 receives pistons 54. When used with fluid pistons 54 it is preferred the bore 55 of the frame member 52 be generally cylindrical. A linkage 56 and 58 connects the piston 54 to a knuckle 64 which is also connected to an upper arm 62. The knuckle 64 is in turn connected to a wheel 30. A spring 68 generally forces the pistons 54 outwardly. A divider 70 divides the two sides of the frame 52 between the two wheels.

[33] As shown in the Figure 6, a seal A can define a fluid cylinder, such that hydraulic or pneumatic fluid can be received on both sides B and C of piston 54. This embodiment can also be utilized simply with atmospheric air pressure, and without the need for seals.

[34] Figure 7 shows one half of an embodiment 90 having very similar structure including a divider 92. In this embodiment a floating piston 94 separates chambers 95 and 97. Chamber 95 preferably includes a resilient gas spring and chamber 97 preferably includes a hydraulic fluid. The function of such suspension components is generally as known, as it is the inclusion of such components into the frame element 91 which is inventive here.

[35] Figure 8A shows an embodiment 120, wherein the dividing wall 122 separates the frame element 123 into the two sides as in the prior embodiments. A gas spring 124 communicates fluid through a tap 126 into a chamber 128 to control the fluid force on the piston 130. Again, a connection 132, 134, 137, 138 and 139 connects the piston 130 operatively to a wheel.

[36] Figure 8B shows another embodiment very similar to the Figure 8A embodiment except an electronically controlled valve 144 is placed on the gas spring 142. In this way, the flow of fluid into the chamber 128 can be carefully controlled to achieve particular dynamic control.

[37] Figure 9 shows an embodiment 150 having opposed pistons 154 and 156 on each side of the frame element 151. A divider 152 divides the frame element 151 into two components. This embodiment provides control over vehicle roll as will be

described. If an upward force on the left hand side lower control arm 181 is transmitted through the linkage 182 to the piston 156, the fluid in the chamber 158 is driven into the chamber 190 on the right hand side through the tube 164. This will drive the piston 154 to the left, in turn causing the control arm 200 on the right hand side to move upwardly in the same general direction as the control arm 181. At the same time, fluid from the piston chamber 158 associated with the right hand side of the Figure 9 embodiment is driven through its tube 164 into the chamber 162. Housing surfaces 161 provide a mount surface for a spring 160. As the control arms 181 and 200 are moved upwardly, the vehicle roll is leveled providing more stable maneuvering.

[38] Figure 10 provides yet another embodiment 170 having floating pistons 172, springs 182, pistons 184, housing structures 186, and the associated linkages shown generally at 240 and such as are shown in the above embodiments. A control line 174 communicates with a chamber 180 between the pistons 172. A motor and pump 178 and a reservoir 176 selectively drive hydraulic fluid into the chamber 180.

[39] This embodiment allows for control of vehicle height. An appropriate control could be utilized to decide when to move the vehicle and how much, and the motor and pump 178 is controlled in view of those goals. In this embodiment, the pump could actively control the suspension. In the specifically illustrated embodiment only a coil spring 182 is utilized in conjunction with the piston 172, however, a fluid controlled spring can also be utilized under this embodiment.

[40] Figure 11 shows yet another embodiment wherein the frame 190 has its bore 200 provided as an air reservoir. Air is pumped from a compressor 210 into the bore 200 and stored. Valves 198 are under a control 202 to selectively deliver air to a suspension component 204 which utilizes compressed air. The suspension component and its use of air are as known. It is the storage of the air within frame element 190 which is inventive here.

[41] Essentially the frame element is a structural frame element which provides structural support to the overall vehicle frame when mounted to other frame components. Typically the frame element is removably attached to other frame elements such as by bolting. Most preferably, the frame element extends across the

lateral width of the vehicle, although in some embodiments this is not required. Further, the frame element is preferably part of a modular combination which is incorporated into the vehicle.

[42] Several embodiments of this invention have been disclosed, however, a worker of ordinary skill in this art would recognize that various modifications would come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content.